nec/77

spring professional growth institutes

register early

Institute 1 — May 22-24
Introduction to Micro/Minicomputers

- Computer Fundamentals
- Basics of Micro & Minicomputers
- Micro/Minicomputer Comparisons
- Software and Programming
- System Design
- Field Problems and Solutions
- Micro/Minicomputer Applications

Institute 2 — May 22-24
Microcomputer Basics and Programming

- Basic Concepts of Microcomputers
- Fundamentals of Microcomputer Software
- Microcomputer Assembly Level Programming
- Programming Workshop and Examples
- Microcomputer Architecture Fundamentals
- Comparison of Commercial Microcomputers
- Applications and Design

Institute 3 — May 22-24
Successful Design/Project Management of Micro/Minicomputer Systems

- Successful Management
- Organization of Projects
- Design Requirements & Specifications
- Successful Vendor Relationships
- Costs, Risks in System Design/Implementation
- Software Management
- Experiences of Expert Designers
- Hardware Design and Interfacing Techniques

Institute 4 — May 22-24
Modern Signal Processing Design Techniques

- Analog Signal Processing
- Approximation Theory
- Discrete Linear Systems
- Z Transforms
- Infinite and Finite Impulse Response Digital Filters
- Quantization, Accuracy and Limit Cycles
- Discrete and Fast Fourier Transforms
- Hardware, Applications and Design Examples

Institute 5 — May 25-27
Microcomputer Architecture, Interfaces and System Design

- Comprehensive Microcomputer Architecture
- Commercial Microprocessor Comparisons
- Input/Output, Memory and Peripheral Devices
- Interfacing Techniques
- Microcomputer Economics and Trends
- Design Examples
- Risk Reducing Design Techniques

Institute 6 — May 25-27
Micro/Minicomputer Software Development and Systems Diagnostics

- Hardware Diagnostic Theory
- Maintenance Philosophies
- System and Component Diagnostic Techniques
- Principles of Software Design
- Data Structures and Program Organization
- Memory Management
- Microprogramming
- Real Time Software Design

Institute 7 — May 25-27
Minicomputer Architecture, Interfaces, Programming and Applications

- Minicomputer Hardware
- Comparison of Commercial Minicomputers
- Interfacing a Minicomputer
- Peripherals: Printers, Terminals, Disks, Tapes, Others
- Programming
- Operating Systems and Compilers
- Applications
- Design Problems and Examples

Institute 8 — May 25-27
Design and Production of Hybrid Circuits

- Basics of Hybrid Technology
- Working Relationships with Hybrid Manufacturers
- Writing Hybrid Specifications
- Design of Hybrids
- Components, Materials Layout
- Power, Voltage and R.F. Design Considerations
- Hybrid Circuit Manufacturing
- Developing In-House Capability
- Design and Product Examples

A continuing education activity in engineering sponsored by National Engineering Consortium, Inc., Oak Brook, Illinois (Incorporated not for profit)

NATIONAL ENGINEERING CONSORTIUM, INC.
PROFESSIONAL GROWTH IN ENGINEERING INSTITUTES

NEC is a technology oriented educational organization (not-for-profit) sponsored by prestigious engineering universities with thirty years of dedicated service to the engineering community.

NEC's management, consisting of industry and university executives, identified a significant problem in the post war era, the need for continuing education, opportunities for their staff. The NEC Professional Growth Institute Program was developed to meet this need, the upgrading of engineers in areas of greatest technological change. Thousands of engineers and managers have attended these high quality seminars. The seminars are presented by faculty and technologists who are eminently active in their subject field.

Virtually all of the participants have praised the Institutes as an effective means for rapidly learning new technology and applying information gained at the seminars to their jobs. In many instances, the NEC Institute was the only organized source of data relative to the new technology subject. Participants, particularly praise the notes — often over 700 pages — which are a thorough compendium of information presented in the institute.

The quality and uniqueness of the NEC Professional Growth Institute Program has been recognized by the awarding of a grant from the Arthur J. Schmitt Foundation for continuing education of university faculty. Professors from most of the major American Universities have attended professional growth institutes over the past five years. They have utilized seminar information to upgrade their educational programs, establish laboratories and develop research programs. University professors are encouraged to apply for a grant under the Schmitt Scholars Program.

The NEC Professional Growth in Engineering Program features outstanding educational Institutes designed to upgrade all participants, from novice to sophisticated practitioners, in the area of small computers. The week long Institutes are dedicated to provide in-depth information on the most important electronic development of the decade—micro/minicomputers. The use of programmable small computers is revolutionizing industry. New products employing small computers emerge every day. Corporations are using small computers in many manufacturing and business applications. All-in-all, the past impact of small computers has been dramatic and the next five years will see many more times the applications thus far achieved.

Eight Professional Growth In Engineering Institutes

The NEC Spring Series of Engineering Institutes are designed to upgrade managers and engineers in the areas of small computers, signal processing and advance components.

Six Institutes are devoted to small computer subjects, they are:

- **Introduction To Micro/Minicomputers** - An introductory Institute requiring no computer background, covering basic computer concepts and micro/minicomputer details and applications.
- **Microcomputer Basics and Programming** - An Institute requiring computer knowledge and covering programming, design and comparisons of commercially available microcomputers.
- **Successful Design/Project Management of Micro/Minicomputer Systems** - Requires mini or microcomputer knowledge and covers practical guidelines for successful project management, hardware design principles, design experiences and tips on avoiding problems.
- **Microcomputer Architecture, Interfaces and System Design** - Requires programming knowledge and covers architecture, components, systems, of microcomputers together with economics, future trends, and design examples.
- **Micro/Minicomputer Software Development and Systems Diagnostics** - Requires assembly level programming and covers indepth principles of software design together with system design for maintenance and tests of hardware.
- **Minicomputer Architecture, Interfaces, Programming and Applications** - Requires computer experience and covers architecture, interfaces, peripherals, software, systems and design examples of minicomputers.

Two three day Professional Growth in Engineering Institutes in the most important circuit design and implementation areas will also be presented. They are:

- **Modern Signal Processing Design Techniques** - Requires Electrical Engineering degree and covers analog and digital filter design techniques together with design trade-offs, comparisons, and applications.
- **Design and Production of Hybrid Circuits** - A basic seminar covering fundamentals, design, manufacturing and applications of hybrid circuits.

Individuals interested in participating in the NEC program are urged to read the detailed Institute summaries and outlines and plan to attend the Institutes best suited to their needs.

Pheasant Run Lodge, St. Charles, Illinois

The Summer series of NEC Institutes will be presented at Pheasant Run Lodge, St. Charles, Illinois, one of the nation's outstanding continuing education facilities.

- Thirty years of experience and dedicated educational service to the engineering community has well equipped NEC to organize and present top level engineering meetings. In addition to great care in selecting faculty and course material, considerable effort is placed in selecting resort facilities which have a quiet, informal environment, conducive to learning.
- Pheasant Run Lodge, only 45 minutes west of Chicago's Loop, is in the beautiful Fox River Valley. Rambles over 300 acres of magnificent countryside. The handsome rustic fieldstone and timber lodge surrounded by an 18-hole championship golf course has a dinner-theatre for dining and entertainment.
- Institute sessions and workshops will be conducted in Pheasant Run's Gallery Hall, a newly-constructed, spacious, air-conditioned conference building. Featuring the latest in classroom equipment, comfortable furniture, and carpeting throughout. The facilities are entirely self-contained, separate from the Lodge itself.
- A comfortable private room is reserved for each registrant.
- Your Institute registration fee includes daily luncheon and dinner. Morning and afternoon refreshment breaks are also included.
- You will take a break one evening and attend the famous Pheasant Run Playhouse.
- As an NEC participant, you can anticipate a rewarding — valued professional growth experience.

NATIONAL ENGINEERING CONSORTIUM, INC. **Continuing engineering education activities (Incorporated not for profit)**
1211 West 22nd Street Oak Brook, Illinois 60521 Phone: 312/325-5700

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UNIVERSITY OF NOTRE DAME
UNIVERSITY OF WISCONSIN

NEC/77 Spring Institute Schedule

NEC has arranged a unique Spring 1977 Engineering Institute Schedule which allows registrants to participate in two complete compatible Institutes. Individuals interested in the study and application of small computers can select from among six Mini/Microcomputer Institutes which will be presented during the week of May 22 - 27, 1977.

Individuals concerned with Circuit Design and implementation areas will also have an opportunity to attend both the Signal Processing and Hybrid Circuits Institutes.

The Schedule outlined below lists the subject areas and dates of presentations. It also provides guidance relative to prior education and experience required.

Institutes 1 thru 4 commence Sunday evening, May 22 and terminate Tuesday evening May 24th.

Institutes 5 thru 8 commence 8:30 am Wednesday, May 25 and terminate Friday afternoon, May 27th.

The registration fee for each Institute is $395.00. Individuals planning to participate in two Institutes will achieve a substantial savings. Total registration fee for two Institutes is $595.00.

Please register early. If possible telephone register. Phone NEC Registrar at 312/325-5700.

Plan to attend two Institutes and Save

Institutes 1 thru 4 Commence Sunday Evening, May 22, 1977

Institute 1 — Introduction To Micro/Minicomputers
- No computer background required
- Basic computer concepts
- Micro/Minicomputers details and application ..... See Page 4

Institute 2 — Microcomputer Basics And Programming
- Prerequisite: Computer knowledge
- Microcomputer programming, and hardware
- Details and comparisons of commercial microprocessors .... See Page 5

Institute 3 — Successful Design/Project Management of Micro/Minicomputer Systems
- Prerequisite: Mini or microcomputer knowledge
- Practical guidelines for successful project and software management
- Design experience and methods to avoid design problems ... See Page 6

Institute 4 — Modern Signal Processing Design Techniques
- Prerequisite: Electrical Engineering degree
- Digital and analog filter design techniques
- Digital filter design trade-offs, comparisons and applications . See Page 7

Institutes 5 thru 8 Commence Wednesday Morning, May 25, 1977

Institute 5 — Microcomputer Architecture, Interfaces and System Design
- Prerequisite: Seminar 1 or 2 or assembly level programming
- Microcomputer Architecture, components and systems
- Economics, future trends and design examples ..... See Page 8

Institute 6 — Micro/Minicomputer Software Development and Systems Diagnostics
- Prerequisite: Seminars 1, 2 or 3 or assembly level programming
- System design for maintenance and test
- In-depth principles of software design ..... See Page 9

Institute 7 — Minicomputer Architecture, Interfaces, Programming And Applications
- Prerequisite: Seminars 1, 2 or computer experience
- Minicomputer architecture, interfaces and peripherals
- Software, systems and design examples ..... See Page 10

Institute 8 — Design And Production of Hybrid Circuits
- No prerequisite required
- Basics, design manufacturing, and applications
- Effective ways to obtain hybrid circuits ..... See Page 11

introduction to micro/minicomputers

institute 1
may 22-24, 1977

A fast moving educational Institute especially designed to teach basic concepts and the latest infromation on micro/minicomputers. It is vital that engineers and managers associated with micro/minicomputer projects become intimately aware of basic concepts, advantages, limitations and other factors necessary in the successful selection and implementation of small computer systems.

The widespread usage of micro/minicomputers throughout all aspects of industry, government and university applications has been truly phenomenal.

All engineers and managers associated with products, services or production techniques which could utilize micro/minicomputers should attend the NEC Institute. Past Participants have widely acclaimed this NEC Minicomputer Institute as the finest continuing education program in small computers. Faculty members are drawn from practioners who have been extremely successful in the design and implementation of systems utilizing small computers.

This Institute is designed for the professional without a computer background. Basic fundamentals of computers are presented in an easy to learn manner. Past participants have praised the material and presentations, saying that this Institute prepared them to make technical and managerial decisions in the small computer field. Participants are encouraged to attend one of the following institutes as described on page 3.

Topics to be discussed:

- Basic fundamentals of computers
- How to use computers
- What is a microcomputer
- What is a minicomputer
- Characteristics of micro/minicomputers
- How to compare today's micro/minicomputers
- How to use a micro/minicomputer
- Alternate Systems configurations
- Overview of micro/minicomputer software
- Design considerations for micro/minicomputer systems
- Real world field problems and solutions
- Extensive micro/minicomputer applications

This seminar offers unparalleled opportunity for the professional without a computer background to prepare to make management and technical decisions about micro/minicomputers.

outline

SESSION 1: **Dr. Richard C. Born**
BASICS OF DIGITAL COMPUTERS. This is an optional session for participants having no computer background. The session begins with a description of number systems such as binary, octal, and hexidecimal. Operations on binary numbers are described. Fixed point and floating point data formats are covered. Instruction formats commonly used in computers are described. Emphasis is given to special schemes for memory addressing. A basic computer system consisting of Input/Output, control, arithmetic logic unit, and memory is described. Based on the computer system, elaboration of data flow within a computer is presented to provide computer fundamentals for subsequent sessions.

SESSION 2: **Dr. Lloyd J. Kusak**
INTRODUCTION TO MICRO/MINICOMPUTERS. This session begins by describing the general characteristics of micro/minicomputers. These characteristics set small computers apart from other classes of computing equipments. Specific features are examined together with their operational specifications and costs. These include: memory, instruction sets and formats, parity checking, memory protect, interrupt structure, power fail interrupt, direct memory access, read only memory, microprogrammable computers, peripherals. For the variety of peripherals and add-on portions of small computers, specifications will be developed as well as fundamentals of operation. Comparative computer costs and pricing factors are also addressed.

SESSION 3: **Dr. Lloyd J. Kusak**
MICRO/MINICOMPUTER PROGRAMMING OVERVIEW. A major challenge facing the participant who implements a small computer system is having a software system which effectively performs the necessary system functions. The session begins with a discussion of the overall scope of software including operating systems/executives, language translators, editors, debuggers, applications programs, and user programs. The various levels of programming language are described: machine, assembly, and higher level. For higher level language programs, the methods of obtaining machine code through compilers and interpreters is described. A comparison includes features such as core size, number of statements, ease of modification, and other factors. Various functions of operating systems are summarized. Since operating systems are batch, multiprogramming or realtime, each category is described to provide particpants with basic concepts. Methods of obtaining software are discussed together with techniques for evaluating software systems.

SESSION 4: **Dr. LeRoy H. Anderson**
MICROCOMPUTER SYSTEMS APPLICATIONS AND DESIGN CONSIDERATIONS. Microcomputers are being applied on an increasingly large scale in a wide variety of applications. This session identifies a broad range of applications primarily in the control field. The microcomputer in these cases is part of a modular programmable control system which has considerable flexibility. For each application, a description is presented as well as practical design considerations. The overall design of the programmable controller is described together with various hardware and software accessories which aid in effectively using it. Specific experiences in microcomputer reliability, problems in applications integration, and special environmental problems as temperature, electromagnetic interference, and hostile environments are described.

SESSION 5: **Dr. R. Eugene Goodson**
APPLICATION OF MICRO/MINICOMPUTERS TO PROCESS AND PRODUCTION CONTROL This session provides an overview into the process and production control applications area. Information on sampling rates and basic reliability factors in the systems are described. A detailed discussion of two case studies provides the participant with information on specific approaches to automation projects. These case studies are the computer control of a newspaper plant and the adaptive computer control of a glass coding process.

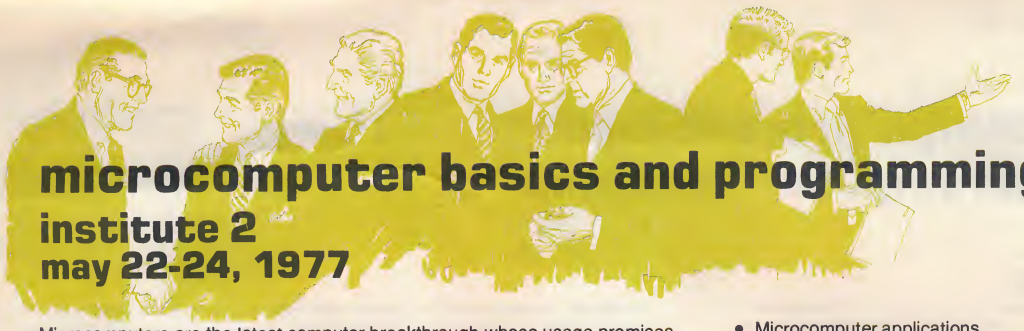
faculty

Dr. LeRoy H. Anderson, President, Comstar-Warner and Swasey Electronic Product Division. Has constructed a family of microprocessor based controllers used in a wide variety of applications. Previous experience in computer and control systems. Formerly Electrical Engineering faculty member at the University of Minnesota. B.S., M.S., Ph.D., University of Minnesota.

Dr. Richard C. Born, Associate Professor, Electrical Engineering Department, Michigan Technological University. Involved in teaching and research in digital design and computational areas. Has experience in programmable processors including minicomputers and microcomputers. Is a consultant to industry in digital systems design area. B.S.E.E., Michigan Technological University; M.S.E.E. and Ph.D., University of Wisconsin.

Dr. R. E. Goodson, Director of Interdisciplinary Institute for Engineering Studies and Professor of Mechanical Engineering, Purdue University. Formerly, Chief Scientist U.S. Department of Transportation. Developing automation concepts and systems to improve manufacturing productivity. Previously, Director of Purdue's Automatic Control Center involved in design of Computer based industrial Control System. A.B., B.S.M.E. Duke University; M.S.M.E., Ph.D. Automatic Control, Purdue University.

Dr. Lloyd J. Kusak, Senior Systems Analyst, Hewlett-Packard Company. Experience includes project management of process control systems, development of computerized message switching systems and general applications of minicomputers in data acquisition. B.Sc. and M.Sc., Queen's University; Ph.D., Cornell University.



microcomputer basics and programming

institute 2
may 22-24, 1977

Microcomputers are the latest computer breakthrough whose usage promises to be substantially greater than minicomputers. Managers and technologists must learn how to apply these new computers to current and future products. Hundreds have particpated in Microcomputer Institutes to learn about today's and tomorrow's microcomputers.

The Microcomputer Insititute is designed for participants with higher level computer programming or minicomputer knowledge. Individuals not having such background should attend the "Introduction to Micro/Minicomputers Institute". The Introductory Institute provides an excellent foundation in small computers.

Participants in "Microcomputers — Basics and Programming" will learn:

- Computer arithmetic and logic
- Fundamentals of digital computers
- Basic concepts of Microcomputers
- Fundamentals of microcomputer software
- Assembly-level programming of microcomputers
- Microcomputer architecture
- Comparison of commercially available microcomputers
- Microcomputer applications
- Applications examples emphasizing practical design techniques

The Institute begins with the basic concepts of microcomputers. Emphasis is placed on looking at the microcomputer as a class of digital computers. Assembly level programming for microcomputers is explained in detail. Programming examples are presented and participants program several problems.

The Institute presents a discussion of the architectural alternatives available to the user in the market today. These alternatives are microprocessors having an increasing level of capability. Commerically available microprocessors will be compared and their characteristics presented in detail. Systems applications are discussed emphasizing practical design considerations such as reliability, environmental conditions and maintainability.

The Microcomputer Institute will provide participants an excellent working knowledge of microcomputers. Also, the frank opinions, forecasts and economic information will aid important product and process implementation decisions. Because microcomputers offer such attractive economics, numerous applications exist today and many more will be developed in the near future.

Participants should plan to attend one of the institutes offered following this institute at large savings. See page 3 for details.

outline

SESSION 1: **Dr. Lloyd J. Kusak**
INTRODUCTION TO MICRO/MINICOMPUTERS. This session begins by describing the general characteristics of micro/minicomputers. These characteristics set small computers apart from other classes of computing equipments. Specific features are examined together with their operational specifications and costs. These include: memory, instruction sets and formats, parity checking, memory protect, interrupt structure, power fail interrupt, direct memory access, read only memory, microprogrammable computers, peripherals. For the variety of peripherals and add-on portions of small computers, specifications will be developed as well as fundamentals of operation. Comparative computer costs and pricing factors are also addressed.

SESSION 2: **Dr. Andre G. Vacroux**
COMPARISON OF COMMERICAL MICROPROCESSORS. This session defines the microprocessor in terms of its size, complexity and capabilities. The microprocessor is compared to hard wired logic, minicomputers and custom large scale integrated circuits. The basic functional configuration of a microcomputer is described. This consists of a microprocessor, control memory, memory, and clock. Classes of microprocessors are detailed including their characteristics and block diagrams. Clock circuits commonly used in microcomputers are described. Random access semiconductor memory is described in detail. A number of technologies apply to these memories: bi-polar, static MOS, dynamic MOS. Basic principles that most microcomputer utilize are described. The design of random access memory arrays is covered.

SESSION 3: **Dr. Andre G. Vacroux**
MICROCOMPUTER PROGRAMMING I: BASICS. The limited word length and memory sizes available in today's microcomputers requires considerable emphasis on effective microcomputer programming. This session begins by describing the relationship between microcomputer hardware and software. Basic classics of instruction sets utilized in microcomputers are described. These include data move, data manipulation, decision and control, and input/output. The various locations for data movement instructions are summarized. Specific examples of microcomputer data manipulation are described. Lucid descriptions of methods whereby programs can jump, call or branch are presented. For microcomputer interfaces, the I/O instructions vary considerably from microprocessor to microprocessor. Examples of techniques used by commercial microcomputers are described. An extensive survey is included of the programming characteristics of commercially available microprocessors. To provide a framework for assembly level programming of microcomputers, a very simple microcomputer is described. The instruction set is presented as well as specific information on registers, read only memory and random access memory. Each of the instructions for this microprocessor are carefully explained.

SESSION 4: **Dr. Andre G. Vacroux**
MICROCOMPUTER PROGRAMMING II: PRODUCING SOFTWARE. Successful microcomputer system requires planning, preparation and testing of software. In planning, it is important to estimate the capability of a microprocessor to perform the function. The specific control logic to be used must be carefully planned. These must correspond to the capabilities of the microcomputer and peripheral devices. The specific working software routines must be described. The overall program control to assure effective operation must be designed. Utilization of hardware resources such as memory and registers must be carefully planned. The important software functions required to integrate all of the above activities are presented. Once the overall design plan is complete, the software analyst begins to prepare code. For microprocessors, the programmer uses assemblers, editors, loaders, compilers and microprogramming. Each of these programming tools is described in detail. As microprocessors become used in the field, program libraries build up. These libraries can assist in software implementation function. Software simulators permit programs to run on machines other than microcomputers. Control panels allow programs to be run beginning at memory locations identified.

SESSION 5: **Dr. Andre G. Vacroux**
PROGRAMMING EXAMPLES. This session concentrates on presenting a variety of example problems which are programmed for the hypothetical microcomputer utilized in Session 4. For each program, the problem is carefully identified and the specific steps in the solution are defined. To expand the participants' knowledge of comparative programming on commercially available microcomputers, programs are written for several microcomputers in response to a specific problem. The number of steps required as well as specific instructions are readily observed. The problems described increase in the difficulty to permit participants an opportunity to observe a variety of challenges.

SESSION 6: **Dr. LeRoy H. Anderson**
MICROCOMPUTER SYSTEMS APPLICATIONS AND DESIGN CONSIDERATION. Microcomputers are being applied on an increasingly large scale in a wide variety of applications. This session identifies a broad range of applications primarily in the control field. The microcomputer in these cases is part of a modular programmable control system which has considerable flexibility. For each application, a description is presented as well as practical design considerations. The overall design of the programmable controller is described together with various hardware and software accessories which aid in effectively using it. Specific experiences in microcomputer reliability, problems in applications integrations, and special environmental problems as temperature, electromagnetic interference, and hostile environments are described.

faculty

The faculty chosen for the microcomputer institute have extensive experience in microcomputers and have continually revised and upgraded their materials over the last three years. Institute notes contain 400 pages of latest information on microcomputers.

Dr. Lloyd J. Kusak, Senior Systems Analyst, Hewlett-Packard Company. Experience includes project management of process control systems, development of computerized message switching systems and general applications of minicomputers in data acquisition. B.Sc. and M.Sc., Queen's University; Ph.D., Cornell University.

Dr. LeRoy H. Anderson, President, Comstar-Warner and Swasey Electronic Product Division. Has constructed a family of microprocessor based controllers used in a wide variety of applications. Previous experience in computer and control systems. Formerly Electrical Engineering faculty member at the University of Minnesota. B.S., M.S., Ph.D., University of Minnesota.

Dr. Andre G. Vacroux, Chairman, Department of Electrical Engineering, Illinois Institute of Technology. Previously, Member of Technical Staff, Bell Telephone Laboratories, Holmdel. Vast experience in development of microprocessor controlled monitoring systems for communications equipment. Diploma d'Ingenieur, Ecole Superieure d'Electricite (France). M.S.E.E., University of Notre Dame, Ph.D. (M.E.) Purdue University.

successful design/project management of micro/minicomputer systems

institute 3
may 22-24, 1977

NEC presents a new institute providing in-depth design and management procedures for engineers and managers who design products and systems using either microcomputers or minicomputers. NEC Institutes on minicomputers and microcomputers provide an excellent foundation in these disciplines. This Design Institute extends where Minicomputer and Microcomputer Institutes leave off. The Design Institute provides in-depth technical information on systems design and practical design considerations. The Institute features management factors proven successful in many programmable system design projects.

The Institute is organized for engineers and engineering managers who have a basic understanding of mini or microcomputers.

Participants will learn:

- Management factors critical to success
- Organization of project teams
- How to analyze design requirements
- How to write a computer specification
- How to work with vendors
- Costs and pitfalls in planning and installing a micro/minicomputer system
- How to save time and money in installation
- Successful software management
- Basic design framework for small computers
- Experiences of expert designers
- Real-world design problems and solutions
- Digital Hardware design principles
- Interface techniques

The "Successful Design/Project Management of Micro/Minicomputer Systems Institute" is designed to provide the participant a well rounded body of information on successful implementation of small computer systems. The Institute begins with a presentation on effective management principles. These principles summarize the successful analysis of the application together with practical tradeoffs to assure meeting requirements. Steps in implementing a computer system are described. Software managment is emphasized since most small computer system developments require extensive software implementations.

The Institute continues with practical design principles for mini/microcomputers. These principles are presented in such a manner as to fully appraise the application and determine the most appropriate small computer implementation. Hardware design concepts are emphasized including successful methods for interfacing computers with other devices.

It is recommended that participants should have attended NEC's Minicomputer or Microcomputer fundamentals seminar or be familiar with Minicomputers of Microcomputers. Alternately, participants who have a computer background are also qualified to attend. Participants are encouraged to attend one of the following institutes at significant savings.

outline

SESSION 1: **Dr. Andre Vacroux**
MINI/MICRO COMPUTER SYSTEM DESIGN TEHCNIQUES. The use of a small computer within a system or product, offers an opportunity for the designer to make use of the programmable features in varying models or future capabilities. To effectively use this asset, the designer must fully understand the application. This session summarizes the types of questions which must be asked to define the system requirements. These questions include inputs, outputs, functions, information storage, flexibility, and expandability. An orderly approach to obtaining this information is presented. Based on the application information, a specific outline is offered as to hardware/software trade offs, hardware development and integrating hardware and software. This session offers a framework which the designer can use to guide him through the analysis and design phases of his development program.

SESSION 2: **Robert M. Janowiak**
SUCCESSFUL PROJECT MANAGEMENT. This session covers the most important management factors to successfully implement a system using minicomputers or microcomputers. The phases necessary to proceed from analysis of the application through successful implementation are described. In analyzing the application, a variety of factors must be considered. One of the essential parameters is the permissable down time of the system. System approaches for various down times are described. The session emphasizes the steps necessary to go from the definition of the applicant's problem through the development of functional and computer specifications. Methods of dealing with computer venders are described. These include relationships with local sales representatives and vendor management, conduct and contract negotiations. Yardsticks are summarized which may be used by the project engineer to assure success of the project.

SESSION 3: **E. Daly**
SUCCESSFUL MANAGEMENT OF SOFTWARE DEVELOPMENTS. In the application of small computer to system design, greatest effort is usually in software development. This session describes the software development problem with emphasis on proven methods to achieve project goals. The logical breakdown of the software project into phases is described. For each of the phases, management control techniques to define the task, estimate time and cost and control the development are described. Examples are drawn from minicomputer software developments for a variety of communications systems.

SESSION 4: **John Calderone**
DESIGNING HARDWARE AROUND PROGRAMMABLE MACHINES. Minicomputers and microcomputers must be incorporated with other hardware to perform the real world functions. Beginning with the application environment, the engineer must determine the hardware design strategy best suited to work with the programmable machine. This includes interfacing with external devices, other programmable machines, auxilliary memories, other peripheral devices, and control panels. The technical tradeoffs of each hardware system are described. Hierarchial programmable systems are also considered emphasizing their impact on reduced software/hardware design.

SESSION 5: **Faculty**
DESIGNERS EXPERIENCES. This is an extremely practical session consisting of presentations by mini/microcomputer designers. A cross section of project engineers have been chosen to describe their experiences. A minimum amount of time will be spent describing their system. The major emphasis will be on problems experienced by the designer. Each of these problems will be described in detail together with various approaches used to solve the problem. Both successes and failures will be presented so participants may learn how these successful project leaders coped with major difficulties. After the presentations have been concluded, a panel session will answer participant's questions and further discuss areas of greatest interest.

faculty

The faculty for this Institute has been selected from among the most knowledgeable practioners of mini/microcomputer system design and applications. The faculty has developed an extensive set of notes of the latest information in this field. These notes together with the presentations will provide the system designer and manager a thorough compendium of information on the system design/project management subject.

John Calderone, Manager of Automation Development, Powers Regulator Company, formerly Systems Development Manager, Information Products Division, Rockwell International. Responsible for developing an environmental control system consisting of multiple minicomputers and microcomputer based terminals. Formerly with Bell Telephone Laboratories, B.S.E.E. Purdue University; M.S.E.E. Massachusetts Institute of Technology.

E. B. Daly, Director-EAX Operations, GTE Automatic Electric Laboratories. Responsible for the development of major software systems for communications. Formerly Member of Technical Staff, Bell Telephone Laboratories. B.A. St. Joseph's College; B.S.E.E. University of Illinois; M.S.E.E. University of Illinois; M.B.A. University of Chicago.

Robert M. Janowiak, President — Signal Division, Federal Signal Corporation. Previously Vice-Presidnet and General Manager of Rockwell International's Information Products Division. Developed business using mini/microcomputer based products. Extensive background in small computer systems management as well as electronic systems and software. Formerly, Director of Computer Sciences, IIT Research Institute. B.S.E.E. University of Illinois; M.S.E.E. Illinois Institute of Technology; M.B.A. University of Chicago.

Dr. Andre G. Vacroux, Chairman, Department of Electrical Engineering, Illinois Institute of Technology. Previously Member of Technical Staff, Bell Telephone Laboratories, Holmdel. Vast experience in development of microprocessor controlled monitoring systems for communications equipment. Diploma d'Ingenieur Ecole Superieure d'Electricite (France). M.S.E.E., University of Notre Dame, Ph.D. (M.E.) Purdue University.

modern signal processing design techniques

institute 4
may 22-24, 1977

The new technology of digital filters has created a large impact on numerous traditional design techniques in the areas of communications, radar, sonar, spectrum analyzers, bio-medical systems, computer signal processing, and direct replacements for analog filters. NEC presents two seminars comprising the Signal Processing Institute. These seminars permit engineers and managers to become aware of this important new field.

Digital filters offer superior performance at lower costs than their traditional analog counterparts. Classical analog filters consisting of resistors, inductors and capacitors are being replaced by digital multipliers and shift registers. These modern filters are easily and inexpensively constructed as large scale integrated circuits or configured with programmable computers or hard wired logic.

Digital filters are flexible and design changes can be simulated in computer programs. Both time variable parameter and adaptive filters are readily achievable. Digital filters do not have components which vary with time causing changing performance characteristics. Filter characteristics not achievable using analog techniques are possible with digital filters.

Engineering personnel and managers associated with a wide range of products affected by this technology must become aware of design procedures and the technology's impact. This seminar provides such an excellent opportunity.

Subjects to be covered:

- Review of analog signal processing including Fourier and LaPlace Transforms and s plane analysis.
- Approximation theory including Butterworth, Bessel, Chebyshev and elliptic filter design techniques.
- Development of discrete time analysis concepts as extensions to analog signal processing theory.
- Considerable practice in Z Transforms and Z plane anaylsis through examples and problems.
- Discrete Fourier Transform (DFT), Inverse Discrete Fourier Transform, Fast Fourier Transform (FFT), Chirp Z-Transform (CZT).
- Design Techniques for Infinite Impulse Response (IIR) and Finite Impulse Response (FIR) filters.
- Practical design considerations.
- Variety of digital filter design examples.
- Criteria for design tradeoffs.
- Demonstrations of digital filtering hardware.
- Ability to evaluate impact of digital filtering on products and systems.

The Signal Processing Professional Growth Seminar offers an outstanding opportunity to gain valuable information in this new technological field. Over a thousand participants have praised the Signal Processing Seminar as an extremely worthwhile learning experience. Participants in the Seminar will receive one of the most extensive set of notes available in this field.

outline

SESSION 1: **Dr. William H. Tranter**
REVIEW OF MATHEMATICAL TECHNIQUES. Upon registering for the seminar, participants will receive notes reviewing mathematical techniques. This session will review the major mathematical tools necessary for modern signal processing designs. The Fourier and the Laplace Tranforms are fundamental to filter design. They provide information on filter response. The filter transfer function will be described with emphasis on frequency and phase response. The mathematical convolution technique will be described as it applies to the design of filters. Emphasis will be placed on amptitude and phase response as two of the most important filter parameters.

SESSION 2: **Dr. William H. Tranter**
ANALOG FILTERS DESIGN. The concepts of the amplitude and phase characteristics required for filter designs will be expanded upon with emphasis on standard lowpass filter designs. The lowpass filter is the basic building block of other filter types. Emphasis will be placed on standard filter functions such as Butterworth and Bessel. Additional standard designs, Chebyshev and Elliptic will be covered. Design techniques utilizing tables for these filters functions will be stressed. Break-frequency and lowpass to bandpass transformations will be covered to extend lowpass design and do the total range of filter function requirements. Realization of filters from both an active and passive point of view will be described. Specific implementation of active filters will be discussed.

SESSION 3: **Dr. William H. Tranter**
DISCRETE-TIME ANALYSIS TECHNIQUES. This session provides the basic tools required for the systematic design and analysis of digital processors. The sampling theorem is discussed in detail to show that it is possible to represent a continuous signal by discrete samples without significant loss of information. Methods of achieving sampling through analog to digital conversion will be described. The mathematical representation of sampled signals leads to the Z transform and the pulse transfer function. The derivation of Z transform is discussed through the use of examples. An understanding of Z transform techniques leads to the pulse transfer function, from which the frequency response of discrete-time systems can be determined. These allow particpants to understand the relationship which exists between the systems of Session 1 and 2 and their digital counterparts. Since the digital filter design often untilizes a continuous filter as a starting point, an understanding is essential.

SESSION 4: **Dr. William H. Tranter**
REPRESENTATION OF DIGITAL PROCESSORS. The session begins with a discussion of difference equations; a concept fundamental to digital processor analysis and design. The pulse transfer function is defined and its applications to digital processor design developed. Application of the unit pulse response and discrete convolution are presented as methods to represent digital processors. An example is developed so that the concept will be fully understood by particpants. The session continues with the presentation of methods for realizing digital processors from the pulse transfer function such as the direct form, canonic form, cascade structures and parallel structures.

SESSION 5: **Dr. William H. Tranter**
DESIGN OF DIGITAL FILTERS. This session covers a variety of design techniques for digital filters and the transformation of an analog filter into a digital filter. This is advantageous because oftentimes a digital filter is an analog replacement. Discrete integration techniques are discussed along with methods for implementing digital integrators. The classical design techniques of impulse invariance and bilinear transformations are described. Impulse invariance design technique is applicable to lowpass or bandpass filters. Infinite Impulse Response (IIR) design techniques are applied to a series of digital filter design examples. Techniques for transforming frequencies are described. Methods of computer aided IIR filter design are presented. Digital filter design using Finite Impulse Response (FIR) techniques are summarized.

SESSION 6: **Dr. S. A. White**
MATHEMATICAL BASIS OF QUANTIZATION. Analog signal must be represented by digital arithmetic. The digital filter manipulates the signal representation; therefore, the designer must consider roundoff noise, pairing and ordering, and coefficient sensitivity in practical filter design. This session introduces basic quantization concepts and their application to digital filter design.

SESSION 7: **Dr. G. D. Bergland**
DISCRETE FOURIER TRANSFORMS. In this session the Discrete Fourier Transform (DFT), Inverse Discrete Fourier Transform (IDFT), and the Fast Fourier Transform (FFT) are covered in detail. The analogy between the Continuous Fourier Transform and the DFT is presented, as well as the pitfalls associated with carrying this analogy too far. The use of the DFT in performing spectral analysis, convolution, correlation, and the Chirp A-Transform is described. The FFT algorithm is presented as a means of substantially reducing the computational resources needed to compute the DFT.

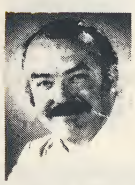
SESSION 8: **Dr. S. A. White**
APPLICATIONS OF DIGITAL FILTERS. Several Digital Filter applications will be discussed. Specific filter design examples will be presented and compared to explain practical implementations of design theory.

faculty

The faculty consists of highly experienced engineers and educators in the field of modern signal processing.

Dr. G.D. Bergland, Head, Advanced System Architecture Department, Bell Telephone Laboratories, Naperville, Illinois. Responsible for exploring software, subsystems. Published numerous papers and has been granted four patents on FFT algorithms and Fourier Transforms. B.S.E.E., MS.E.E., Ph.D. from Iowa State University.

Dr. William H. Tranter, Associate Professor of Electrical Engineering. University of Missouri-Rolla. Present research activities in image processing and CAD of analog and digital communication systems. He is a consultant to NASA and has authored a book on digital communication systems. B.S.E.E., M.S.E.E., and Ph.D. from University of Alabama.



Dr. Stanley A. White, Engineering Staff, Rockwell International, Autonetics. Responsible for the design of digital signal processing system. Previously, he was Supervisor of Advanced Inertial Instrument Research within the Navigation and Computer Division. Has performed extensive research and development in digital filtering, automatic control techniques and on-line signal processors. Formerly Instructor at Purdue University and Lecturer at U.C.L.A., B.S.E.E., M.S.E.E. and Ph.D., Purdue University.

microcomputer architecture, interfaces and system design

institute 5
may 25-27, 1977

The manager and technologist must fully understand both today's and tomorrow's microcomputer capabilities. This seminar is designed for participants who have had assembly level programming experience or who attended "Microcomputer Basics and Programming" or "Introduction to Micro/ Minicomputers" Institutes.

Institute participants will learn:

- Microcomputer architecture
- Comparison of commercially available Microcomputers
- Advantages and limitations of alternate architectures
- Input/Output architecture
- Memory and interface considerations
- Peripheral devices
- Design examples
- Pitfalls in designing microcomputer systems
- Microcomputer economics
- Microcomputer future trends
- System design using microcomputers

The seminar will commence with a discussion of the architectural alternatives available to the user in the market today. Present product offerings as well as future microcomputer trends will be the subject of an in-depth architectural session. Examples of microcomputer design projects will be presented together with a lively session on design problems and solutions. The Institute will move on to the input/output area with emphasis on interfacing techniques. The Institute will conclude with a discussion on systems design using microcomputers and microcomputer selection criteria.

The entire Microcomputer Institute will provide participants an excellent working knowledge of microcomputers. Also, the frank opinions, forecasts and economic information will aid important product and process implementation decisions. Because microcomputers offer such economics, numerous applications exist today and many more will be developed in the near future.

Typical microcomputer applications include:

- terminals
- displays
- printers
- plotters
- keyboards
- calculators
- "smart" instrumentation
- vending machines
- point of sale systems
- medical products
- accounting systems
- process control
- numerical control
- electronic scales
- mini computer replacement
- sophisticated games and toys

"Microcomputer Architecture, Interfaces and Systems Design" is designed for the technologist who has computer experience including assembly level programming. It is suggested that participants having this experience consider also attending "Microcomputer Basics and Programming" which precedes this Institute. Participants who do not have assembly level programming experience or those wishing to "brush up" should attend "Introduction to Micro/ Minicomputers" which precedes this Institute.

outline

SESSIONS 1 & 2: **Dr. James D. Schoeffler**
MICROCOMPUTER ARCHITECTURE. This session begins by detailing all of the architectural elements of a typical microcomputer. Utilizing this information, a number of applications examples are presented. These include a data logging system and point of sale terminal. Techniques whereby the processor is controlled either through program or microgram are described. Based on the information provided for the generalized microcomputer architecture, a thorough analysis includes characteristics and special features such as architectural confirgurations, random access memory, read only memory, timing and other hardware capabilities. Specific data on memory size and memory addressing mechanisms are detailed. A comparison of advantages and disadvantages of various architectural approaches is presented. This session provides considerable insight into the hardware aspects of microcomputers. Registrants not only learn basic information on microcomputer configurations, but also are exposed to specific information on commercially available equipment.

SESSION 3: **Dr. Andre G. Vacroux**
MICROCOMPUTER INTERFACE TECHNIQUES. This session concentrates on microcomputer input/output (I/O) structures, interfaces and frequently used peripherals. The I/O architecture of microcomputers is described. Specific I/O transfer techniques including programmed transfer, interrupt driven control and hardware control are described and illustrated with the most commonly available machines. I/O bus structures are discussed in detail and compared. A wide variety of I/O devices are reviewed from the simple latches and multiplexes to the recently available interface chips such as P.I.A., ACIA . . . Special emphasis is given to interrupt structures and special techniques such as direct memory access (DMA). The peripheral devices most commonly used with microcomputers are reviewed. These include teletypewriter, portable terminals, cassette recorders, floppy discs, magnetic cartridges and modems. The different modes available for transmitting and receiving serial or parallel data are discussed.

SESSION 4: **Faculty**
DESIGNERS EXPERIENCES. This is an extremely practical session consisting of presentations by mini/microcomputer designers. A cross section of project engineers have been chosen to describe their experiences. A minimum amount of time will be spent describing their system. The major emphasis will be on problems experienced by the designer. Each of these problems will be described in detail together with various approaches used to solve the problem. Both successes and failures will be presented so participants may learn how these successful project leaders coped with major difficulties. After the presentations have been concluded, a panel session will answer participants' questions and further discuss areas of greatest interest.

SESSION 5: **Dr. Andre G. Vacroux**
MICROCOMPUTER SELECTION AND SYSTEM DESIGN. Considerable information is presented the Microcomputer Institute, but the participant is faced with the fundamental question of which microprocessor to select for his application. This session provides a comparative analysis of microcomputer features. These features are not only numbers but specific guidelines on various measures of microcomputer power. Features described include hardware, instruction sets and specific hardware/software characteristics. Emphasis is also placed on interrupt capabilities and addressing modes. Management factors such as hardware support, systems houses handling turnkey installations, and software support are described. The detail side-by-side comparative analysis of commerically available microcomputers and their characteristics is provided. To develop a system, an effective form of systems design techniques must be employed. This session describes the types of questions which must be asked for various aspects of system requirements and implementations. These include inputs, outputs, memory, word length, arithmetic and logic functions, and other aspects such as flexibility and expansion. Questions on the microcprocessor selection process are also included. Specific guidelines as well as pitfalls in hardware-software trade-offs, hardware development, software development and integrating hardware and software are discussed. This session pulls together the various concepts presented throughout the Microcomputer Instititue and provides practical guidelines on the effective implementation of a microcomputer system.

faculty

Dr. James D. Schoeffler, Chairman, Computer and Information Science Department, The Cleveland State University. Formerly Professor of Engineering and a member of the Systems Research Center at Case Western Reserve University. Teaches and conducts research in the area of computer control and systems engineering. B.S. and M.S. degrees in Electrical Engineering from Case Institute of Technology; Sc.D. degree from MIT.

Dr. Andre G. Vacroux, Chairman, Department of Electrical Engineering, Illinois Institute of Technology. Previously, Member of Technical Staff, Bell Telephone Laboratories, Holmdel. Vast experience in development of microprocessor controlled monitoring systems for communications equipment. Diploma d'Ingenieur, Ecole Superieure d'Electricite (France). M.S.E.E., University of Notre Dame, Ph.D. (M.E.) Purdue University.

micro/minicomputer software development and systems diagnostics

institute 6
may 25-27, 1977

The growth of minicomputer/microcomputer systems has been truly phenomenal. These systems are being used in a wide range of applications from simple toys to large electronic switching systems. This NEC Institute is especially organized to enable the participant to effectively design small computer based systems. The hardware portion of the product can be manufactured in the traditional way. Software modification permits low cost change from model to model or application to application.

Since software costs are often 3-5 times the system cost, emphasis is placed on an orderly presentation of software development techniques. Oftentimes, unsuspecting users acquire a system and then become painfully aware of the difficult and expensive software problems involved. This results in additional hardware required and the added expenses in both cost and development time. Specific approaches described in the Institute will enable the designer to fully understand software developments pertaining to small computers.

Hardware/software systems need to be effectively diagnosed in the field. Many computer designs do not consider this factor causing extensive downtime and considerable expense. A session is dedicated to the principles and practice of design for ease of test and maintenance.

This Institute will provide participants:

- System design theories for diagnostics and maintenance
- Test instrumentation and test systems
- In-depth principles of software design
- Software approaches to hardware savings
  - Data structures
  - Program organization
  - Microprogramming
- Extensive real time software considerations
- Software development techniques
- Comparison of today's minicomputer executives

The Institute has an extremely competent faculty consisting of the most successful practioneers in the field. A comprehensive set of notes has been developed which provides each participant a complete record of the Design Institute. There will be time for questions and answers and informal discussions with the faculty. The participant will learn extensive design principles which he can apply to this new technology.

outline

SESSION 1: **Alfred K. Susskind**
DESIGNING FOR EASE OF DIAGNOSTICS AND TESTING. Although the system utilizing mini and microcomputers has substantial flexibility and product appeal, the combination of hardware and software causes difficulty in diagnosing failures. The designer must be aware of techniques useful for servicemen and maintenance personnel in maintaining and repairing equipment. This session will define fault models commonly used in digital systems. Important computer diagnostic techniques such as logic simulation, fault directories, and diagnostic tracing will be described. Various techniques for measuring the performance of a programmable system to aid in diagnosing failures will be summarized.

SESSION 2: **Dr. James D. Schoeffler**
SOFTWARE FOR REAL TIME, ONLINE APPLICATIONS. On-line, real time applications such as data-acquisition, laboratory automation, process control, message switching, discrete parts manufacturing, monitoring and control all lead to software implementations in the form of a set of programs cooperating to carry out the application. These applications are discussed in order to define their response time and other important characteristics. The corresponding software engineering problems which must be solved in order to successfully implement the application are described. This session defines requirements for real time, on-line applications software. These requirements are addressed in subsequent sessions which describe software engineering.

SESSION 3: **Dr. Charles W. Rose**
SOFTWARE FOR COMMUNICATION AND BUSINESS APPLICATIONS. Minicomputers are providing an economic solution to many online real time business applications. Examples including sales forecasting, small business accounting systems, ledger keeping, inventory control, point-of-sale retail sales are discussed to define their software engineering needs. These needs include specific requirements of minicomputer executives, system response times, and file handling needs. These requirements are addressed in subsequent sessions.

SESSION 4: **Dr. James D. Schoeffler**
DATA STRUCTURES AND THEIR USES. Various organizations of data are available and the choice in any particular application affects significantly the design and performance of the rest of the system. Fixed and variable data organizations are discussed including arrays, tables, lists, queues, stacks, and trees. Ordering techniques for file records are described including sequential, indexed sequential, multiple indexed sequential, loops, and the hashing function. Files and file handling techniques in minicomputer systems are discussed.

SESSION 5: **Dr. Charles W. Rose**
CONTROL STRUCTURES AND THEIR APPLICATIONS. There is a need to coordinate the multiple tasks operating essentially in parallel to carry out an application. Control structures which facilitate this coordination are discussed including the problem of shared I/O resources, shared system subroutines, control over re-entrancy, etc. Implementation of the needed control structures via semaphores, event flags, and message communication is discussed.

SESSION 6: **Dr. James D. Schoeffler**
INTERPROGRAM COMMUNICATION. A major characteristic of real time applications is the multiplicity of programs cooperating to carry out the application and their need to communicate with each other. Methods of communication of data between programs is discussed including permanent allocation in memory. Fortran blank and named COMMON, files, data tables, message transmission systems, and event flags. Communication through system subroutines and their associated problems are also described.

SESSION 7: **Dr. Charles W. Rose**
COMPUTER TO COMPUTER COMMUNICATION. The trend toward multiple computers in an application is evident today and this implies computer-to-computer communication as an integral part of system operations. Organizations of hardware and software to facilitate this communication is discussed with emphasis on message protocols, error correction, communication between tasks, accessing of remote data, and recovery after a system failure. The structure of computer networks and line sharing systems for input/output is also described.

SESSION 8: **Dr. Charles W. Rose**
MICROPROGRAMMING. Many current small computers permit user microprogramming so that certain critical tasks or portions of tasks may be implemented in a very efficient manner. Examples include often used routines within Fortran monitors and subroutines, special data acquisition tasks, and certain data structure manipulations. Principles of mircoprogramming are described. Microcprogramming applications illustrate how this tool can be used effectively in critical realtime software systems.

SESSION 9: **Dr. James D. Schoeffler**
MEMORY MANAGEMENT AND SCHEDULING. Main memory is one of the most critical resources in a real time system. Management of memory affects real time response very significantly. Alternatives for memory management including overlays, partitions, dynamic allocation, virtual memory and memory mapping techniques are presented. Scheduling of tasks via run-to-completion, multiprogramming, priority multiprogramming, and time slicing are presented as methods of controlling real time response.

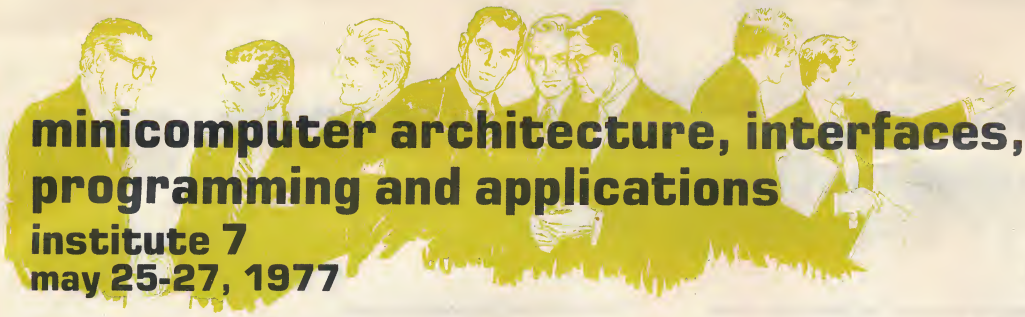
SESSION 10: **Dr. James D. Schoeffler**
MINICOMPUTER EXECUTIVES. The modules which comprise a realtime minicomputer executive are discussed emphasizing the way memory management , scheduling, interprogram communication, and other key software engineering factors interact to determine the applications for which the executive is suited. Specific executives of current minicomputers are then discussed in order to compare how various minicomputers support different realtime application areas. A variety of executives is chosen to illustrate different memory management schemes, different scheduling algorithms, use of memory mapping hardware and other factors.

faculty

Dr. James D. Schoeffler, Chairman, Computer and Information Science Department, The Cleveland State University. Previously, Professor of Engineering and a member of the Systems Research Center at Case Western Reserve University. Teaches and conducts research in the area of computer control and systems engineering. B.S. and M.S. degrees in Electrical Engineering from Case Institute of Technology, Sc.D. degree from MIT.

Alfred K. Susskind, Professor and Chairman of Electrical Engineering at Lehigh University, Bethlehem, Pa. His research has concentrated on diagnostics for digital networks. From 1948 to 1968, Professor Susskind was a faculty member at M.I.T. where his major research interests were in computer design, numerical control of machine tools, information retrieval, and switching theory. B.E.E. Polytechnic Institute of Brooklyn; S.M. Massachusetts Institute of Technology.

Dr. Charles W. Rose, Associate Professor, Case Western Reserve University. Research in minicomputer hardware and software. Has applied computer systems to discrete process control, automatic checkout, and tactical command and control. B.S.E.E., M.S.E.E. Duke University; Ph.D Computing and Information Science, Case Western Reserve University.



minicomputer architecture, interfaces, programming and applications

institute 7

may 25-27, 1977

The widespread usage of minicomputers throughout all aspects of industry, government and university applications has been truly phenomenal. Minicomputer sales are well in excess of the one billion dollar mark. Virtually every major corporation has investigated and implemented the use of minicomputers in some aspect of their business. During the last several years, minicomputer prices have been substantially reduced and greater interface and software capabilities exist. These advances have widened the application of minicomputers.

All engineers and managers associated with products, services or production techniques which could utilize minicomputers should attend this Institute, which provides detailed information on minicomputer hardware and software for the professional with modest computer background:

- Alternate systems configurations
- Minicomputer hardware architecture
- Ways to interface a minicomputer
- Available peripherals and their characteristics
- Minicomputer programming techniques
- Software utility programs, compilers, executives and operating systems
- Minicomputer applications
- Design problems and examples

NEC has organized this extremely successful minicomputer seminar to acquaint managers and technologists with practical information on this powerful new tool. The NEC Minicomputer Institute was lauded in IEEE's "Spectrum" as an "excellent seminar". Virtually all of the past 1,000 participants have expressed their satisfaction with this unique, concentrated method of learning.

The NEC Professional Growth Seminar provided them:

- an excellent understanding of computer architecture
- minicomputer software fundamentals
- practical information on how to use minicomputers
- methods of interfacing minicomputers to their applications
- cases on successful application of minicomputers
- performance and cost information
- excellent background to analyze their applications

This seminar is oriented for technologists and managers engaged in all scientific disciplines, manufacturing, and process control. Participants should understand computer fundamentals but are not experts on minicomputers. It is highly recommended that participants having no minicomputer background attend the "Introduction to Micro/Minicomputers" Institute during the beginning of the week. The combination of the two seminars will permit a participant to get both basic and fundamental knowledge on minicomputer hardware, software, and applications.

Participants will obtain an outstanding set of notes from both seminars which will permit application of seminar principles to be easily applied. Seminar faculty members will be available to discuss specific requirements of participants.

outline

SESSION 1: **Kenneth E. Burkhalter, Jr.**
CHARACTERISTIC MINICOMPUTER ARCHITECTURE. This session begins by describing basic computer organization and features. General memory, program, and computer control registers are identified, including instruction, register, memory buffer register, memory address register, and program counter. The role registers play in memory addressing is discussed. The various types of working registers are described together with the details of their functions. The arithmetic/logic unit performs computational and logic operations upon data in working registers. The organization of a typical ALU is described. Functional sequences are guided by a control unit. Examples of how such a unit operates are presented. Memory plays an important role in a minicomputer and is one of the major cost elements. Various configurations of core and read only memories are described,

SESSION 2: **Kenneth E. Burkhalter, Jr.**
INPUT/OUTPUT AND BASIC PERIPHERAL DEVICES. Input/Output architecture of typical computers is described together with program and hardware control techniques. I/O data and bus structures are described. Characteristics of I/O bus configurations common to minicomputers are described in detail. Various bus structures such as radial, party-line, and Daiseychain are discussed. Methods of interrupting minicomputer operations to accept or send information through the I/O are described. Interrupt features such as enable/disable, arm/disarm, and priority are presented. Common forms of interrupt include conditional, single-level/single-port, multi-level/single-port, singel-level/multi-port and multi-level/multi-port. High data transfer rates require that peripheral devices such as magnetic tape units or disk memories be connected directly to memory. Various methods of direct memory access are described.

SESSION 3: **Dr. Lloyd J. Kusak**
MINICOMPUTER PROBLEMS. Participants are given minicomputer application problems to solve. Problems are discussed in other sessions and solved on Friday.

SESSION 4: **Dr. Lloyd J. Kusak**
SOFTWARE FUNDAMENTALS I. This session begins by discussing the organization of memory words in small computers. Typical instruction repretoires are described based upon a general minicomputer configuration. This repretoire is similar to those availabe in commercial equipments. For many of the instructions, details of computer operations are described. The session then covers memory addressing concepts such as pages, indirect addressing, floating selectors, bank switching, indexing, and intermediate instructions. Details of writing a program for a minicomputer are discussed. These include a discussion of assemblers and macro instructions. The session extends to microcomputers by discussing typical instruction sets and programming techniques.

SESSION 5: **Dr. Lloyd J. Kusak**
SOFTWARE FUNDAMENTALS II. This session begins by discussing utility programs which are used to perform auxiliary functions in a small computer software system. Examples include loaders, input/output routines, editors, debugging aids and diagnostic/maintenance aids. The subject of higher level languages is addressed. As the cost of memeory lowers, more and more users are utilizing higher level language for software systems. Properties of these software systems are described, such as input/output facilities, program management, and memory management. Practical considerations determining how best to obtain minicomputer software are described.

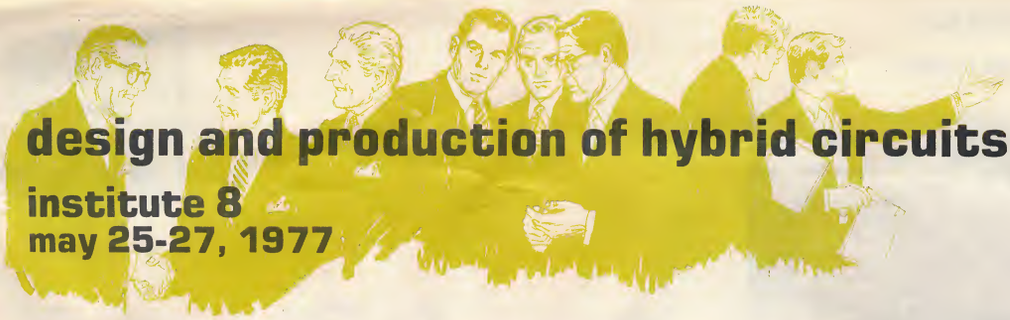
SESSION 6: **Dr. Lloyd J. Kusak**
MICRO/MINICOMPUTER APPLICATIONS. A variety of computer applications are discussed including a microcomputer controllers, refinery process control, computer-to-computer communications, computer-to-satellite communications, engineer test stands, non-destructive testing of coating thicknesses, engineering evaluation of control systems, automatic testing of electronic modules, on-site process analysis, acoustical research facility.

SESSION 7: **Dr. Lloyd J. Kusak**
MICRO/MINICOMPUTER PROBLEMS DISCUSSIONS. The problems presented in Session 2 will be discussed. For each problem, participants having different solutions will describe their approach so all can learn from various attacks on the design problems.

faculty

Dr. Lloyd J. Kusak, Senior Systems Analyst, Hewlett-Packard Company. Experience includes project management of process and control systems, development of computerized message switching systems and general applications of minicomputers in data acquisition. B.Sc. and M.Sc., Queen's University; Ph.D., Cornell University.

Kenneth E. Burkhalter, Jr., Senior Product Planner, Sycor. Formerly, Principle Research Engineer, Scientific Research Laboratory, Ford Motor Company. Responsible for development of microcomputer systems for vehicle and engine electronics control. Formerly, Director of advanced development for Omnitext, Inc. Has designed systems, components, terminals, interfaces, and communications oriented microprocessors. Lecturer on computers and digital logic design. MSE degree, University of Michigan.



design and production of hybrid circuits

institute 8
may 25-27, 1977

NEC is proud to present this new institute on "Design and Production of Hybrid Circuits." The Custom Hybrid field is growing rapidly with more applications going to hybrid form. The rugged, high performance packaging is increasingly attractive to many commercial and industrial applications. The automotive industry is using hybrids for electronic ignition systems, voltage regulators, and radios. Hybrids are used throughout the new portable, two-way radio designs. Many other consumer products are using hybrids. Controllers for hand drills is a specific product. In the instrumentation area, hybrids reduce circuit size and provide both better performance and extremely reliable operation.

Hybrid technology ties together other advanced digital and linear semiconductor technologies. For example, the newer, larger scale integration (LSI) digital circuits may be used in die form together with peripheral components to form a totally functional package. Hybrid technology does not compete with the semiconductor technologies but acts to tie together components into functional modules. A Hybrid circuit consists of miniature analog and digital discrete components applied to a substrate which also has components and conductors deposited upon it. A Hybrid circuit is a small, rugged, very reliable electronic device.

The advantages of hybrid technology include the following:

- small size and weight
- special packaging-circuit configured to product
- form of protection from competitive copying
- high performance capability
- very reliable
- useful D.C. to R.F.
- wide range of power
- digital, analog or combination
- uses commercially available semiconductor dies
- high packing density multi-layer hybrids
- ideal for module level maintenance
- low investment cost
- competitive unit cost
- short development to production cycle
- production capability requires only modest investment

Every circuit designer and manager responsible for electronic products should understand hybrid technology. This institute offers and ideal opportunity to learn about this important area.

Participants will learn:

- Basics of hybrid technology
- Design techniques for different circuit types
- Applications and design examples
- How to work with hybrid manufacturers
- How to write a specification
- Ways to partition a circuit
- Worse case analysis for reliable design
- Components and materials used in hybrids
- Power/voltage design considerations
- Radio frequency design considerations
- Mechanical design factors
- How hybrids are produced
- Types and costs of production equipment
- How to develop your in-house hybrid capability
- Examples of products which are now in hybrid form

The institute offers circuit designers and managers a unique opportunity to learn whether hybrid circuits are applicable to their products. Also, participants will learn how to design hybrids, ways to work with hybrid manufacturers and how to develop a hybrid capability in their own company. Individuals considering participation in this institute should also consider attending one of the other institutes offered on page 3. Participation in both seminars is offered at an excellent cost savings.

outline

SESSION 1: **Frank Leingang,**
OVERVIEW OF HYBRID TECHNOLOGY. This introduction session provides basic information on what is hybrid technology. Hybrid technology has great value as a compact form of integrating circuit designs. The use of standard passive and transistor technology as well as newer medium scale integration (MSI) and large scale integration (LSI) are also discussd. Fundamental information on practical design factors is provided. Included are descriptions of circuit types which are implementable as hybrids. For each circuit, types of components as well as common interconnections are described. The overview session concludes with a discussion of production techniques commonly used in hybrid manufacturing.

SESSION 2: **Frank Leingang,**
WORKING RELATIONSHIPS WITH HYBRID MANUFACTURERS. Most users do not have in-house hybrid manufacturing capabilities. Therefore, the first hybrid circuits employed in products or processes are obtained from a hybrid manufacturer. The relationship between designer/user and a hybrid manufacturer may be on a black box or schematic basis. In the black box case, the user specifies all input/output conditions of the circuit as well as transfer functions, logic truth tables and other design requirements. Power ratings as well as environmental factors are specified. The hybrid manufacturer takes on repsonsiblity to design the circuit and implement it effectively in hybrid form to meet the black box specification. In the relationship using schematic diagrams, the circuit is designed by the user. He then communicates this circuit design to the hybrid manufacturer who implements it in hybrid form. Such an implentation requires a detailed design specification and worse case analysis.

SESSION 3: **Roydn Jones**
HYBRID CIRCUIT DESIGN TECHNIQUES. This detailed design session will acquaint the circuit designer with all factors necessary to successfully implement a hybrid design. The session begins with a discussion on how to translate a breadboard or printed circuit board design into hybrid form. The circuit must be analyzed from a worse case point of view. Tolerance on all components must be carefully specified. Based on the hybrid packaging format chosen, the circuit must be partitioned in a logical format. The session then describes methods of estimating substrate area. This is done through a knowledge of sizes required for components, interconnects, power dissipation, and other special design requirements. Standard substrate sizes are discussed as well as special sizes to meet unusual product requirements. The session then describes details of the hybrid design. Specific design factors for conductors including width, spacing, resistivity, cross overs, clearances within constraints of geometric, voltage and power considerations. The sizes and types of component chip pads are discussed for semiconductors and capacitors. Also, exit pads and wire bonding pads are described. The design of resistors including types of resistor inks, initial resistivities, and resistivity changes due to manufacturing processes. Problems of resistance drift, dimensions, and laser trimming are also presented.

SESSION 4: **Alex Kalling,**
HYBRID CIRCUIT MANUFACTURING. Participants must understand the hybrid manufacturing process to fully appreciate how to implement a design in hybrid form. This session concentrates on how to manufacture hybrid circuits. It presents not only the technology and equipments but also economics. Based on information learned in the session the participant will be able to evaluate his company's capabilities to implement a hybrid manufacturing facility. The session begins with the manufacture of ceramic substrate sheets including raw materials storage, ball mill processing, ceramic casting, punching of parts utilizing carbide tools, and heat treating in kilns. Once the ceramic substrates are available, screen printing processes are used to apply conductors, resistors and capcitors. Components are baked in furnaces utilizing belt drives. Methods of controlling the process by adjusting the speed of belts is discussed. After the substrates have the necessary deposited componentry, discrete components are added. These include chip capacitors, silicon devices and leads.

SESION 5:
HYBRID CIRCUIT DESIGN APPLICATION. Thus far, the seminar has provided an overview as well as specific design and manufacturing information. Also, participants have learned how to work with manufacturers. This session is dedicated to teaching through examples how the design process works. In these examples, the design began with a breadboard and progressed through the hybridization phase. For each of the designs, a discussion of specific design challenges and problems will be made. The designs presented will cover a broad cross section of applications. This session will tie together the information presented in previous sessions to aid the participant in becoming a successful hybrid implementor/designer.

faculty

The faculty selected for this Professional Growth Seminar have an extremely broad background in hybrid technology.

Alex Kalling, Manager of Preproduction Engineering, Circuit Products, Centralab Electronics Div., Globe Union, Inc. Responsible for implementation of new products into manufacturing. Extensive experience in design and production engineering of both thick and thin film hybrid circuits. BSEE, University of Wisconsin.

Frank Leingang, Manager of Marketing, CTS Microelectronics. Responsible for application of custom hybrid circuits to industrial and military requirements. Previously Chief Electrical Engineer responsible for hybrid circuit design. BSEE, MSEE, University of Illinois.

Roydn Jones, Manager of Hybrid Design, Tektronix. Responsible for design of thick and thin film hybrid circuits. Has had experience in design of wide range of circuits from D.C. to microwave. Formerly with Hewlett Packard, B.S. London University.

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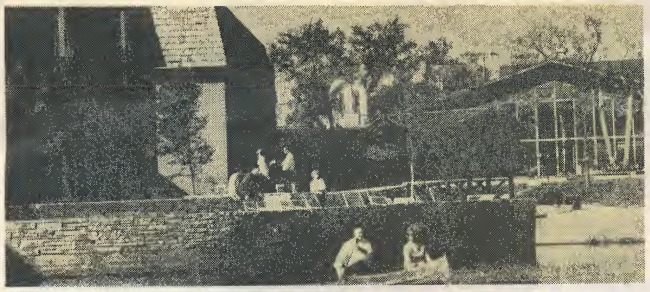

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